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RESEARCH FOUNDATIONS IN THEIR RELATION TO MEDICINE[1]

AT this time and place, medicine is the central interest, and therefore, so far as a layman can, it is my purpose to discuss "Research Foundations in their Relation to Medicine," and if possible to do this in such a manner as to reveal their significance to those for whose encouragement these ceremonies have been devised.

To accomplish this I intend first to ask you to consider the mental attitude necessary for the appreciation of research foundations and then to describe these foundations broadly—trying to indicate their relations to the universities; the problems which arise in connection with them; the dangers to which they are exposed; and their significance for the progress of medicine, for yourselves and for the development of the spirit of research.

You who are about to pass from the discipline of the school to a more self-dependent phase of your career feel both the fresh pleasure of restraints outgrown and a questing interest in the coming years. You feel too that, broadly speaking, what will happen to medicine during the next fifty years will also happen to you, and that at any moment some of you may be called upon to guide these happenings.

In the face of such responsibilities it becomes a duty as well as a wise precaution, to obtain the broadest possible view across your chosen field and to gain knowledge of the larger changes and improvements taking place within it.

You may have done this several times

[1] Address at the graduation exercises of the Yale Medical School, June 17, 1912.

before, but I venture to predict that if you live and succeed, you will do it many times again.

The Greek philosopher Heraclitus laid weight on the idea that all things are in a state of flux. The notion has not always been approved. We know that this idea in some of its aspects was repugnant to the early Victorian gentlemen, but to-day we are less prone than those of earlier generations to dogmatize on the impossible, and in this country and this phase of civilization, we feel with its full force the forward flow of things, so that for us nothing is more certain than the progressive change and onward movement in medical theory and hence in medical practise.

During the years of your training you have been carried more or less unconsciously along and thus helped to keep in touch with the development of medical thought, but at this moment, when the stream of knowledge is about to cast you out upon its shores and you are asked to walk on alone, it is worth while to inquire what is your preparation for the experience.

From these halls and laboratories you bear away a load of learning—haply you bear it lightly. It is to this possession that I wish to direct attention for a moment.

The knowledge we accumulate is a very mixed article, but in this mixture there are two sorts which it is well for us to consider now. One sort consists of certain formulas which control our incidental actions; for instance, we all know on occasion when to stand up or to sit down, and you know the technique and procedure for various surgical operations. A great fraction of our information is in this form, a form not necessarily subject to frequent or radical change. This sort, however, is of minor interest to us now, and has been mentioned here only that it may serve as a foil to the more important kind.

This more important kind of knowledge is that on the basis of which we can foresee and predict.

There are manifold varieties of this and they range from that which permits us to predict with a high degree of confidence the rising of to-morrow's sun, to that with which one ventures to predict the weather or the fate of a patient with baffling symptoms.

In these latter instances the course of events is by no means unpredictable, but only so dependent on complex factors and conditions that we rarely have at once at hand enough information to make a respectable guess. This fact bears very directly on the matter before us, for when we scrutinize our intellectual possessions we find them to consist in large measure of information useful for prediction, yet mainly information so incomplete that the conclusions or theories—if you choose—based on it must be largely held as open to revision and therefore can be used with safety only by those who carry in mind just how much or how little each conclusion has to rest upon. Nevertheless, it is just these tentative conclusions or theories which the medical man must so largely utilize. Probably you have thought of this before; if so, you know that to the revelations of this analysis men react in very different ways. Some throw up their hands in the face of so much uncertainty; others stretch certainty to the limit and seek to make it cover all they have been taught and then cultivate impenetrability because change is disquieting and new knowledge means new labor, while those born under happier stars are neither crushed nor blinded, but recognize that intellectual health and vigor imply an unceasing replacement of both data and conclusions, to be accomplished only when the period of

mental growth is made conterminous with life.

Capacity for such continued growth is conspicuous in the masters and a hall mark of the eminent. Indeed, as you proceed in the investigation of your fellows, you will be surprised to find how early growth may cease and how significant the event can be. In far-distant communities mental growth has been known to stop on commencement day. It is consoling, however, to be assured—as I can assure you—that we observe this woeful arrest more clearly and sooner in our fellows than in ourselves—a suggestive fact which needs only to be mentioned in order to be appreciated.

As you see, the reason for this preface touching the nature of our mental possessions is my wish to emphasize the need for the full recognition of the unsolved or partly solved problems in medicine and the necessity for holding in mind the facts on which all such tentative solutions as we use are based. When this need has been recognized, it is possible to take the point of view from which research foundations can be discussed with greatest benefit, for primarily it is their purpose to replace less certain by more certain facts. Indeed, discussion of these foundations can be significant only for those who, like yourselves, know that the students' career is for life, never to be commuted—not even for good behavior—and in no wise limited by any formal function, such as graduation or a state board test.

Turning now to the research foundations themselves, it may be well, by way of introduction, to give a word of explanation touching the coming treatment of them. I desire to speak as an inquirer, not as an advocate, but as these inquiries have led me to some definite conclusions, I shall venture to express them briefly. Beyond this, all things rest with you.

While we are specially interested in research foundations in their relation to medicine, yet those with such relations are but a fraction of the number in existence and for the most part have come late.

A research foundation may be defined as one especially intended to produce new and better knowledge. Thus the main purpose and aim serves broadly to differentiate such a foundation from the universities and other educational establishments in which a greater emphasis is put on the conservation, distribution or application of knowledge, while at the same time both sorts of institutions have been and are producers also. The new foundations are then by no means essentially novel, but in one sense outgrowths or specialized extensions of the older educational establishments. This implies of course that what they are devised to do has already been included in the existing scheme of things.

Such being the case, our discussion must be framed so as to comprise these facts.

In the civilization from which we are descended there has always been some endeavor to add to the sum of human knowledge.

The acute minds belonging to the end of the medieval period often overstepped the theological and philosophical bounds within which they had their greatest activity, and gave to the study of the physical world more or less attention. Speculating, compiling, teaching and even experimenting, these men grouped here and there formed the centers from which the earliest universities of our era sprang.

Later appeared the learned academies, also sometimes the patrons of investigation. As objects of study, the physical problems came first, aided by the fact that observational and experimental work could be there begun without the preliminary labors of collection and classification which have

necessarily occupied so much time in the biological sciences.

What is important to point out here is this: That whether we date the founding of the modern university laboratory from Lomonossoff at St. Petersburg in 1748, or from Liebig at Giessen in 1826, we must admit that a good deal of investigation had gone on in all the principal departments of science previous to such foundations, and thus in earlier times investigations were made in scientific workshops unconnected with teaching institutions. This fact suggests that perhaps our research foundations have even less novelty than we were at first inclined to accord to them, and that we are dealing now rather with a reappearance of conditions—much improved, to be sure—but quite familiar before the rise of our modern universities. It has a direct bearing on this point to note that in England, for example, during the earlier part of the last century when the historic universities of that country gave only meager support to experimental science and especially to the biological investigations, much of the most important work was done outside of the teaching institutions.

Joule, the student of the mechanical equivalent of heat; Perkin, discoverer of the aniline dyes; Bentham and the Hookers, all three botanists; Galton, the anthropologist, and Darwin, are some instances.

Moreover, for more than a century the Royal Institution of Great Britain, the foundation of which in 1799 was largely instigated by our fellow countryman, Count Rumford, furnished opportunities for research to Davy, Faraday, Tyndall and Dewar, all men whose contributions to knowledge have been of great importance.

According to its charter, the Royal Institution was "an establishment in London for diffusing the knowledge of useful mechanical improvements" and "to teach the application of science to the useful purposes of life."

This does not sound like the program of a research institution to-day. I can not say just what the steps were which led in this case to a development seemingly so different from that proposed, but it is not rash to assume that the men like those who have been named were always hunting reasons and explanations, knowing quite well that others could carry out the application, while it was theirs to make the fundamental discoveries; an excellent example of the well-known fact that where an institution and a strong man are left to work out the problem of adaptation, it is the institution that gets adapted.

Returning from this diversion to our history, and taking the period from the middle of the preceding century to the present day, one can not fail to recall in this country such an example as the Smithsonian Institution at Washington, and I would add our agricultural experiment stations which started right, then faltered, but are now coming into their own.

More extensive in scope and with far greater resources than any of these is the Carnegie Institution of Washington, whose magnificent undertakings in the field of science are well known, representing as they do a long series of research stations.

The ideas behind these several foundations are of the greatest interest. In his program of organization, in 1847 Joseph Henry, first secretary of the Smithsonian Institution, states the following:

> To increase knowledge: it is proposed (1) to stimulate men of talent to make original researches by offering suitable rewards for memoirs containing new truths and (2) to appropriate annually a portion of the income for particular researches under the direction of suitable persons.

This is what one might expect from Joseph Henry.

Touching the agricultural experiment stations, the history is complicated and perplexing, but we are justified, I believe, in carrying back the guiding idea in their development to that expressed by Washington in his annual message to Congress in 1796, where he says, when pleading for the establishment of a national board of agriculture, that one of the functions of such a board should be "to encourage and assist a spirit of discovery and improvement . . . by stimulating to enterprise and experiment." This is certainly sound doctrine.

The Carnegie Institution in the original formulation of its general plans was much influenced by the experience and early program of the Smithsonian Institution, but the original statement of aims strikes a new note when it declares one of these aims to be

> To discover the exceptional man in every department of study whenever and wherever found, inside or outside of schools, and enable him by financial aid to make the work for which he seems specially designed, his life work.

It is said that this paragraph touching the exceptional man has caused much trouble to the Carnegie Institution and often spread its path with thorns. It appears that in some instances it has been misunderstood. Self-discovered exceptional men have proved to be embarrassingly numerous. That does not strike one as so very strange, however, since the community grows wise but slowly.

The word "exceptional" you see has suffered misinterpretation. The really exceptional man is not so often the aberrant prodigy as the individual who presents in his composition a large collection of first-rate qualities, no one of which is necessarily alarming, but all of which together make for scientific effectiveness of the highest order. In the course of its development, the Carnegie Institution has, I think, lived up to this ideal with notable success —putting the saner interpretation on the word "exceptional." My commendation of the paragraph is similarly based.

But none of these instances which I have mentioned—together with a large group of others—come very close to medicine. This contact was first clearly established in 1888 by the Pasteur Institute in Paris, an institute intended to facilitate the work of the great scientist whose name it bore, and to continue the remembrance of him. It was an instance of the generous giving of aid and assistance to a master-man—with no prescriptions and no hampering limitations. Pasteur was a genius who combined the art of mediation between the laboratory facts and practical problems, with the capacity for speculative thought and scientific achievement in the highest sense, and who, nevertheless, did not allow his human interest to impair his scientific thoroughness.

In this country among the foundations closely related to medicine we have recently seen established the Rockefeller Institute, the Memorial Institute for Infectious Diseases, the Ortho S. A. Sprague Memorial Institute, both of these at Chicago, together with a number of others representing much the same purpose, but with less ample resources, as well as several funds devoted to the study of cancer, tuberculosis or other special diseases. These instances, because they touch medicine, might well be examined in detail, but we shall discuss them only in their most general relations.

It seems a fair question to ask why these institutes and funds have been established. The immediate causes are plain enough, and are frankly philanthropic in most cases. Personal experience with a disease has led more than one man to devote a large sum to the search for its control or cure or going a step further, and recognizing that the application of laboratory

results to medicine has brought progress, some have desired to furnish opportunities by which this application may be accomplished where it seemed most needed. Though not always explicitly expressed, the programs of these foundations imply the hope that by such endowments new facts and new points of view fundamentally important to medicine may be discovered.

I like to think that this last idea is at least latent in all these endeavors, but nowhere, so far as I know, is quite the same note struck as that which is sounded in the initial program of the Carnegie Institution in those words which call attention to the exceptional man—the investigator.

Turning now to some of the relations involved, it is to be observed that these new foundations are independent and not connected with existing universities, that they tend to draw men from university positions by the attraction of unusual opportunities for work, and finally, that for the most part they take these men away from formal teaching.

The situation thus created in the world of education has often been lamented and no little moral pressure is exerted from time to time to induce the institutes to see the wrongness of their position.

The question thus raised amounts to this: Are these new foundations philanthropic vagaries and mere torsos of educational establishments, or do they represent the result of mature consideration and a definite endeavor to advance?

Of the several reasons which have brought about the independence of these foundations the common desire to keep alive the donor's name and fame has played its part, but more than this I think has been the feeling that since these foundations were to be devoted to research, either in the line of mediation to which I have already referred, or in the endeavor to obtain new truths of fundamental importance, therefore the workers in these institutes should be as far as possible released from any duties likely to divert their energies. To make this arrangement within the limits of a university is, to say the least, to subject the favored appointee to no little strain.

His colleagues, being human, at heart often resent his seeming freedom from responsibility and he is allowed to feel that somehow he does not justify himself by attending to his work alone. It is unnecessary to enlarge on this situation, but I can assure you that it is no mere product of my fancy. Separateness of management brings protection therefore to those who choose this work.

Still more important for ultimate success is the general conduct of such a foundation. Our universities are guided by experienced administrators who feel keenly the need for the diffusion of knowledge, for making it accessible to large numbers and for preserving withal a completeness and balance in their institutions.

These views become ingrained, but they do not represent the aims of a research foundation and the same board could hardly manage both with like success. For the investigator, buildings are fine when they suit his purpose; after that he loses interest. His notion of efficiency is a large emergency fund and whether the fixed charges are great or small is not so important as the means to act promptly, decisively and even expensively when occasions arise. This arrangement is possible only when the institution is a good deal of a unit and absolutely free.

To appreciate the needs thus briefly outlined requires the experience which breeds sympathy, and it has thus come to pass that so far as the arrangement of the scientific program, the formation of the personnel

and the expenditure of funds are concerned, the control in many of our institutes is in the hands of the staff, aided by a small group of scientific advisers, themselves active workers and keenly alive to the needs of the investigator. This leaves the actual care of the funds with the trustees, but puts the scientific activities in the hands of scientific men. The arrangement solves several problems and seems essential for the healthy development of research foundations.

In view of all of these facts it does not appear very strange that independence has been desired for the newer establishments.

This brings us to the problem of getting men—men who will attempt to realize the highest aims and aspirations of these foundations. These have been taken largely from university laboratories and have been attracted to the newer work by the prospect of more time and resources to apply to their chosen problems and by more fitting salaries.

Of course it has happened at times that in arranging the program of some foundations, emphasis has been put on finding the answer to some specific question which was in the donor's mind. This is unfortunate so far as it implies a limitation of the scientific work, but on the other hand, in many cases the investigator has been given ample freedom to pursue his own course and devote his time to matters often seemingly remote; in other words, to follow where his research led. The situation demands above all things faith in the sincerity of purpose of the investigator, and fortunately this is granted with increasing frequency.

In these institutions which serve to mediate, on the one hand, between the findings of science and practical problems, and on the other to give opportunity for the attainment of fundamental facts, there is a constant danger threatening every searcher after new knowledge. The mediation work, because it involves as one element a practical problem, is moderately intelligible to the laity and extremely handy when it comes to giving an account of things done. It may become thereby unduly attractive.

By contrast, the search for the new knowledge is rarely intelligible to the community at large, and must often be described in terms of things in mind rather than of things accomplished, and thus this kind of activity often lacks for encouragement. Let me illustrate. Some years ago the need of protection from diphtheria was urgent. The infecting organism and its biological characters, on the one hand, were known; on the other, the dread disease was only too familiar. How could laboratory knowledge be used to solve the clinical problem? You are familiar with the answer which was given in the form of the diphtheria antitoxin. That is a splendid example of work in mediation as done in research institutes.

But a further question arises: How does the antitoxin produce its effect? This is quite another sort of problem; at first glance it appears to have little practical bearing and yet the answer to it in even one instance may lead to a wider view of the processes of immunity. The solution of problems of this class is different from the work of mediation, certainly of equal rank with it, and yet in every way harder to support and harder to carry on, since the results can not in the first instance possibly appeal to any save the well-trained few. In this there lies an obstacle to progress which you can largely help to remove.

Because the men who can do this latter kind of work are relatively rare, even among investigators, because such work can have rational appreciation from a limited group only, and because knowledge of this sort is sure to become the basis for many

mediations in the future, it behooves us all to see to it that we foster such investigators —the most valuable of our natural resources. Perhaps it occurs to some of you that you have seen one well-known type of the man I here commend. Let me recall him to you.

An elderly gentleman with an unprogressive costume and unsteady gait, who generally fails to recognize his friends upon the street and requires several seconds to accomplish the recall when spoken to. Such is the mildly humorous picture with which all are familiar. It is often correct so far as it goes—only it is a bit incomplete.

One should add that this man is working with his head, a fact which accounts for almost everything and leaves us pondering why this symptom complex so readily excites remark.

Connected with the conduct of research in these foundations are several other problems of more than passing interest. The fear is sometimes voiced that in the absence of students, those at work will lack an important stimulus and suffer deterioration.

The danger varies with the man. Instances are known where men have failed to feel the attraction of institute opportunities, because they feared the loss of this companionship.

On the other hand, we have the attitude represented by the German university professor who is said to have remarked at the opening of the fall semester, "Now comes this disagreeable interruption of my work." Doubtless he was a wicked old dyspeptic, but for a moment he rose beyond himself and spoke for his burden-bearing caste.

Let me beg not to be misunderstood. I would not for a moment be thought to maintain more than the simple thesis that while teaching is a genuine stimulant to some, it is certainly a depressant to others and especially a depressant to those who are disturbed by interruption, so that some can drop it without damage to themselves.

In compensation it may be urged that the effect of the investigator's methods and personality is felt by those with whom he is usually surrounded, his colleagues and assistants, and when so surrounded he is in no more danger of isolation than a man in the university. However, that is not saying very much, for isolation among colleagues even in universities is a condition which we not only lament, but should also seek to change. It is an ancient tale.

The investigators of four centuries ago were chary of talking of their results and these were often published posthumously, as the authors preferred to die without assistance—or the new discoveries were sometimes couched in cryptic writings as though the author felt that what had given him such years of labor to find out should at least be hard for others to attain. That feeling is sometimes found to-day.

Once I remarked to a student, "Your thesis is three times too long." "Yes," he replied, "but if I did not make it long, how would any one know it had taken me two years to do the work." We can replace this by a better thought. The opportunity to satisfy one's longing for research is a noble privilege, but it brings its obligations. The advances thus made should be returned as rapidly as possible to the fund of common knowledge, and made accessible to the community at large.

This is essential for the progress of the plan, for most surely is the advanced worker dependent on his colleagues as they on him, and ultimately too he is in a larger sense also dependent on the community about him; so for both these reasons cooperation of the most complete sort is needful for the common good.

Expression has been given to the fear that the great resources of our research

foundations would breed despondency among those who were compelled to work with simpler devices and less ample means, and thus they would do harm. Despondency and research do not dwell together.

Research is a frame of mind. A man may have little leisure and trifling resources, may never have published, but if he examines his world in a questioning spirit, if he carries with him not only conclusions, but the observations on which they rest, if he refuses to pound square facts into the round holes that he happens to have in hand, he has attained illumination. The spirit of research is nothing mysterious or remote, it is every-day hard sense. Unfortunately, that does not make it common, but it does make it attainable.

It would be a sorry outcome of these new foundations if they should act as hindrances to investigation in the university laboratories.

The fear that they will do this is often based on the false impression that the supply of scientific problems is limited and thus in danger of exhaustion. Let us be rid of that idea. Every advance creates new problems, problems of increasing importance—exhaustion is impossible.

By reason of the permanency of their programs and freedom from certain forms of responsibility, institutes may wisely undertake investigations of a sort hardly possible under university conditions. The field is thus divided, or rather enlarged. Both the university laboratories and the institutes should gain by this arrangement, and what is more, they do.

Before leaving this aspect of our problem, permit me to point out a peculiar advantage enjoyed by investigators who are working under university conditions. When we contrast the institutes with the universities, we find that it is within the walls of the university laboratory that it is most easy to carry on the search for new knowledge undisturbed by the thought of any applications which it may have.

In the face of some things already said, this statement may appear paradoxical—yet it describes a condition. In the judgment of the educated public, the teaching investigator fulfills his public obligations when he gives a stated amount of instruction. After that, there is a general feeling that the man should be allowed to follow his bent, and if this takes the form of research, the community does not feel obliged to inquire too closely concerning the practical value of the work. Thus in a way the university man is protected in his research by his teaching obligations, while the man in the institute, engaged in the same sort of investigation, is, if anything, more open to criticism, and at the same time without the defense which is possessed by his university colleague, and in so far he stands at a disadvantage.

As you see, I have been concerned in this address with medicine as represented by yourselves in relation to the research institutes, and that explains the manner of this presentation.

It has been my purpose to show that in these foundations we have something which represents an advance in our educational devices.

Their independence is an asset. They may be counted on to mediate in a measure between the initial facts of the laboratory and the problems presented by disease, but more important, though harder to maintain, is their function as laboratories where new knowledge is obtained, which in turn must have still wider applications.

All this concerns you who are just entering on your life work. You can receive direct benefits and enjoy new privileges by reason of these greater opportunities, but they also bring to you fresh responsibilities.

So far as any of you look upon these foundations from without it is my hope that some things have been said which will rouse in you a sympathetic appreciation of the kind of work which I have sought to emphasize as the most precious type of endeavor, for further progress will depend largely on the appreciation and support given to this by the best elements in the medical profession.

The material side of our advancing civilization has developed during a thousand years to an astonishing degree, but we must not be misled, as sometimes happens, into confusing material developments with intellectual progress. These foundations of to-day are but aids to active minds that use them. The mind, the man, is the essential thing, and any device which does not improve him and give him the very best opportunity to increase his powers, has but slight claim to our regard. I desire, therefore, to leave with you a strong impression of the paramount importance of our mental attitude in establishing the right relations between research foundations and medicine.

Permit me then in closing to quote a little fable from Luqman, as it seems to emphasize this point. Luqman, the sage, was reputed, I am told, to have been either an Abyssinian slave of King David or the son of Job's maternal aunt. That question is not settled—but his fable has a pleasant oriental flavor. It runs as follows:

In the heat of the day the lion retired to a cave. While resting there a rat ran over him. The lion jumped up in fright, whereat the jackal laughed. Perceiving this the lion said, "I was not frightened at the rat, but at my own alarm"; thus showing that to the mighty their state of mind is of more moment than death itself.

Henry H. Donaldson

FAMILY RECORDS OF GRADUATES OF WESLEYAN UNIVERSITY

FAMILY RECORDS OF GRADUATES OF WESLEYAN UNIVERSITY

Wesleyan University was founded in 1831, and the first class graduated in 1833. The total number of graduates, including the class of 1910, is 2,849—2,627 men and 222 women. The following statistics relating to married life are given separately for men and women. The first women graduates took their degrees in the decade 1871–80.

1. *Marriages*

In the first decade, 1833–40, 119 out of 142 graduates married (84 per cent.); 21 of them married twice, 3 of them three times, 1 of them four times and 1 five times. In the second decade, 1841–50, 217 out of 264 married (82 per cent.); 47 married twice, 4 three times and 1 four times. In the third decade, 1851–60, 250 out of 276 married (90 per cent.); 50 married twice, 5 three times and 1 four times. From 1861–70, 239 married out of 262 (again 90 per cent.); 37 married twice and 6 three times. In the fifth decade, 1871–80, 271 out of 311 male graduates married (87.1 per cent.); 41 married twice and 1 three times. Five out of the 8 women graduates in this decade married. In the sixth decade, 1881–90, 268 out of 340 of the men married (78.82 per cent.), 14 of them having married twice. Fourteen out of the 29 women graduates of this decade married, that is, 48 per cent. In the seventh decade, 1891–1900, 344 out of the 461 male graduates married (74.62 per cent.); 10 of them married twice. Fifty-one women out of the 95 who graduated in this decade married (53.68 per cent.). In the last decade, 1901–10, 221 men out of 570 have so far married (38.8 per cent.); 3 of them have married twice. Twenty-six out of the 90 women who graduated in this decade have married (28.8 per cent.).

Of the 2,627 male graduates, 1,930 have married (73.46 per cent.). Of the 222 women graduates, 96 have married (43.28 per cent.). The percentage of married women compared

with that of men who graduated in their own classes and have married, is 43.48 per cent. as against 65.7 per cent.

TABLE I

Percentage of Graduates Married

Classes	Men	Women
1833–40	84	—
1841–50	82	—
1851–60	90	—
1861–70	90	—
1871–80	87.1	62.5
1881–90	78.82	48
1891–1900	74.62	53.68
1901–10	38.9	28.8

2. *Children*

In the first decade, 1833–40, from 119 marriages of graduates there were 535 children, 275 boys and 260 girls, an average to the family of 4.49; one family comprised 12 children, four 11 children, four 10 children, and there were only eight childless marriages. In the second decade, 1841–50, from the marriage of 217 graduates there were 750 children, 398 boys and 352 girls, an average to the family of 3.46; there were three families of 10 children each, one of 11 and thirty-two childless marriages. In the third decade, from the marriage of 250 graduates there were 818 children, 396 boys and 422 girls, an average of 3.27; one family consisted of 13 children, one of 11 and one of 10; there were twenty-six childless marriages. In the fourth decade, from 239 marriages there were 688 children, 360 boys and 328 girls, an average of 2.9 to a family; there was one family of 10 children, and there were thirty-two childless marriages. In the fifth decade, 271 male graduates who married had 686 children, 374 boys and 312 girls, an average of 2.53; there was one family of 10 children and two of 9, and there were forty-five childless marriages. The 5 women graduates of this decade who married had 13 children, 7 boys and 6 girls, 8 of the 13 being already reported in the figures of this decade, inasmuch as they were children of women graduates who married graduates of Wesleyan. The average number of children to a marriage of the women graduates was 2.6. In the sixth decade, 1881–90, the 268 male graduates who married had 527 children, 289 boys and 238 girls, an average to a family of 1.96; there was only one large family, made up of 11 children. The 14 women graduates of this decade who married had 28 children, 13 boys and 15 girls, 10 of the 28 being previously reported in the decade owing to intermarriage of Wesleyan graduates; the average to a family in the case of the women graduates of this decade was 2. In the seventh decade, 344 men who married had 488 children, 250 boys and 238 girls, an average to the family of 1.42; there was one family of 8 children. The 51 women graduates of this decade who married had 70 children, 35 boys and 35 girls, 42 of them being previously reported, an average for the women graduates who married in this decade of 1.37. In the last decade, 1901–10, the 222 men who have married have had 180 children, 94 boys and 86 girls, an average to the family of .81; the largest family reported so far is 3. The 26 women of this decade who have married have had 18 children, 7 boys and 11 girls, 10 of them being reported in the 180 above mentioned; the average family to the married women graduates of this decade is to date .69.

TABLE II

Average Number of Children to a Family

Classes	Men	Women
1833–40	4.49	—
1841–50	3.46	—
1851–60	3.27	—
1861–70	2.9	—
1871–80	2.53	2.6
1881–90	1.96	2
1891–1900	1.42	1.37
1901–10	.81	.69

The total number of children of male graduates of Wesleyan to date is 4,672, 2,436 boys and 2,236 girls, an average to the family of 2.42. The total number of children of women graduates who have married is 129, 62 boys and 67 girls, an average to each married woman of 1.34. On account of the large families in the early days, when there were no women graduates, the comparison should, how-

ever, be made between men and women of the same graduating classes. The average number of children of the married men in the same classes as the women is 1.7 as compared with 1.34 for the women. The total number of children of Wesleyan alumni, men and women, excluding duplicates, is 4,731. Of these 1,076 have been reported dead.

Frank W. Nicolson

AN INDEX OF FISH ENVIRONMENTS

In studying the distribution and success of fishes within a given area, one often notes the absence of certain species from localities which appear quite suitable fish habitats upon inspection, or even upon determination of the oxygen content of the water. Evidently, the causes of this absence is not a life and death matter such as is often supposed to be true in animal distribution. But since fishes are able to move readily from place to place, they may leave or fail to enter a locality where the conditions are entirely compatible with life for a longer or shorter period. Yet the change in conditions may be great enough to cause the fishes either to turn back or to leave the locality because of stimulation and increased activity. Wishing to test this reaction possibility, we devised a means of studying the behavior of fishes when they encounter differences in gases or solids in solution. The apparatus consisted of a device giving a constant flow of water with desired amounts of dissolved gases, and at any temperature within ordinary experimental needs. Two tanks, 120 cm. long by 20.5 cm. wide by 14 cm. deep were arranged under identical and symmetrical surrounding conditions. Water was introduced into both ends of the tanks at the same rate and was allowed to flow out at the center. The same kind of water was introduced into the two ends of the control tank. In the experimental tank the water introduced at one end was like that of the control, while the gas content of that introduced at the other end had been experimentally modified. This established a gradient between the two kinds of water. Fishes put into the tanks tend to go back and forth and thus encounter the experimental gradient. When the change of conditions thus encountered was such as to affect the fishes, they reacted either by turning back or by passing through the gradient into the treated water. But in this case they quickly returned to the untreated water, thus spending a shorter time in the treated water.

Eight species of fish, widely separated taxonomically, were studied in detail. All the fishes were slightly negative or indefinite in their reaction to differences in oxygen content. We found no good evidence that they react to nitrogen. Their reaction to water which had lost six parts per million of its salts (mainly magnesium and calcium), 15 c.c. of nitrogen and 2 c.c. of carbondioxide per liter by boiling was about the same as to difference in oxygen content. All the fishes were decidedly negative in their reaction to increased carbon dioxide. The differences tried varied from 5 to 60 c.c. per liter above that in which the fish had been kept. When increased carbon dioxide accompanied low oxygen the negative reaction was very marked; the fishes turned back when the gradient was encountered and only rarely entered the part containing the highest carbon dioxide and lowest oxygen.

Several workers have shown that carbon dioxide is very toxic to fish. It appears to be much more so than corresponding differences (24 c.c. per liter) in oxygen content. Fishes turn away when they encounter an increase of as little as 5 c.c. per liter. Since a large amount of dissolved carbon dioxide is commonly accompanied by a low oxygen content, and other important factors, the carbon dioxide content of water (strongly alkaline waters excepted) is probably the best single index of the suitability of that water for fishes. The methods and these results, as well as others, will be published in detail elsewhere as soon as they can be prepared. These aspects of the results are sufficiently different from what workers appear to have been expecting to justify their publication here on account of

possible bearing on field studies during the present season.

V. E. SHELFORD,
W. C. ALLEE

THE RELATION OF THE HORSEPOWER TO THE KILOWATT[1]

THERE was, before 1911, no precise definition of the horsepower that was generally accepted and authoritative, and different equivalents of this unit in watts are given by various books. The most frequently used equivalent in watts, both in the United States and England, has been the round number, 746 watts; and in 1911 the American Institute of Electrical Engineers adopted this as the exact value of the horsepower. It is obviously desirable that a unit of power should not vary from place to place, and the horsepower thus defined as a fixed number of watts does indeed represent the same rate of work at all places. Inasmuch as the "pound" weight, as a unit of force, varies in value as g the acceleration of gravity varies, the number of foot-pounds per second in a horsepower accordingly varies with the latitude and altitude. It is equal to 550 foot-pounds per second at 50° latitude and sea level, approximately the location of London, where the original experiments were made by James Watt to determine the magnitude of the horsepower.

The "continental horsepower," which is used on the continent of Europe, differs from the English and American horsepower by more than 1 per cent., its usual equivalent in watts being 736. This difference is historically due to the confusion existing in weights and measures about a hundred years ago. After the metric system had come into use in Europe, the various values of the horsepower in terms of local feet and pounds were reduced to metric units and were rounded off to 75 kilogram-meters per second, although the original English value was equivalent to 76.041 kilogram-meters per second. Since a unit of power should represent the same rate of work at all places, the "continental horsepower" is best defined as 736 watts; this is equivalent to 75 kilogram-meters per second at latitude 52° 30′, or Berlin. The circular gives tables showing the variation with latitude and altitude of the number of foot-pounds per second and of kilogram-meters per second in the two different horsepowers.

These values, 746 and 736 watts, were adopted as early as 1873 by a committee of the British Association for the Advancement of Science. The value, 0.746 kilowatt, will be used in future publications of the Bureau of Standards as the exact equivalent of the English and American horsepower. It is recognized, however, that modern engineering practise is constantly tending away from the horsepower and toward the kilowatt. The Bureau of Standards and the Standards Committee of the American Institute of Electrical Engineers recommend the kilowatt for use generally instead of the horsepower as the unit of power.

[1] Abstract of Circular of the Bureau of Standards, No. 34; June, 1912.

THE IMPERIAL UNIVERSITIES CONGRESS

THE Imperial Universities Congress was opened by Lord Rosebery on July 2, at the University of London, South Kensington. As we learn from the reports in the London *Times* the question of the division of work and specialization among universities was dealt with in a paper by Sir Alfred Hopkinson, and Sir Arthur Rücker and Sir Charles Waldstein spoke on the same subject. Principal Peterson, of McGill University, introduced a discussion on inter-university arrangements for post-graduate and research students.

On July 3 there were two sessions of the congress, Lord Curzon of Kedleston presiding in the morning and Mr. Balfour in the afternoon. Papers were read on the relation of the universities to technical and professional education, the interchange of university teachers, and the problem of universities in the east. The speakers and readers of papers included Sir Frederick Lugard, Sir Isambard Owen, Dr. A. E. Shipley, Sir Thomas Raleigh and

Professor Patrick Geddes. Lord Rayleigh and Lord Haldane presided on July 4, and among others Principal W. H. Hadow, Sir Edward Busk and Sir George Gibb were on the program. On Friday, when Lord Strathcona presided, Dr. G. R. Parkin and Sir Alfred Keogh dealt with the question of the establishment of a central bureau, Mrs. Sophie Bryant, Mrs. Sidgwick, and others with the position of women in universities, and Sir James Donaldson and Mr. Michael Sadler with the representation of teachers and graduates on the governing body of a university. The entertainments included a luncheon at the invitation of the government, a reception of delegates by Prince Arthur of Connaught at the University of London, dinners at the halls of several city companies and an "At Home" at the Mansion House.

SCIENTIFIC NOTES AND NEWS

Cambridge University has conferred the degree of doctor of science upon Edwin Brant Frost, director of the Yerkes Observatory.

Among newly created doctors of laws of the University of Edinburgh are Dr. J. S. Phelps, of the Geological Survey, and Professor J. Theodore Cash, F.R.S., professor of materia medica, University of Aberdeen.

Durham University has conferred its doctorate of science on Professor Prafulla Chandra Ray, dean of the faculty of science in the University of Calcutta; Professor L. P. Anderson Stuart, professor of physiology and dean of the faculty of medicine in the University of Sydney.

Cambridge University will confer the degree of doctor of science on Dr. Howard Marsh, professor of human anatomy in the university and master of Downing College.

Dr. R. T. Glazebrook, F.R.S., director of the National Physical Laboratory, has been elected president of the Faraday Society.

At the seventy-eighth annual general meeting of the Royal Statistical Society, Professor F. Y. Edgeworth was elected president.

The *Journal* of the American Medical Association states that the friends, the pupils and ophthalmologists of many countries united recently in celebrating the seventy-seventh birthday of Professor Henri Dor, by presenting him with a portrait medal. The reverse of the medal typifies Dor's life-work, as it represents science pushing back the clouds that the light can fall on the child beside it. The background shows Dor's home on the banks of the Rhone at Lyons where he has been professor of ophthalmology since 1876. He was a pupil of both Graefe and Donders, and founded thirty years ago the *Revue Générale d'Ophthalmologie.*

A new office, that of administrative geologist, has been created on the U. S. Geological Survey, and Dr. George H. Ashley, Ph.D. (Stanford, '94), chosen to fill it. This position is virtually vice-director of the survey, placing the incumbent in complete charge of the organization during the absence of the director, and in addition giving him charge of certain functions of the organization the whole time. Dr. Ashley has been a geologist of the survey since 1901 except for the years 1910 and 1911, when he was state geologist of Tennessee.

The following promotions to the rank of geologist of the U. S. Geological Survey have been made: Robert Anderson, B. S. Butler, Adolph Knopf, F. H. Moffit, G. B. Richardson and A. R. Schultz.

Dr. Chester A. Reeds, for the past four years lecturer and associate in geology at Bryn Mawr College, has been appointed assistant curator of the department of geology and invertebrate paleontology of the American Museum of Natural History. He enters upon his new duties August first, after spending some weeks in Europe visiting museums.

Mr. F. W. Jones, has been appointed chief chemist of the purification works of the Fitchburg, Massachusetts, Sewer Department. Mr. Jones was for some time instructor in chemistry at the Worcester Polytechnic Institute. During the past year he has been assistant

chemist at the Worcester sewage purification works.

AT a meeting of the Lawes Agricultural Trust Committee, held on June 25, Dr. E. J. Russell, at present Goldsmiths' Company's assistant for soil investigations, was appointed director of the Rothamsted Experimental Station in succession to Mr. A. D. Hall, F.R.S.

THE Mackinnon studentships of the Royal Society for the ensuing year have been awarded to H. M. Kyle, D.Sc. (St. Andrews), for a research on the metamorphosis and origin of the flat fishes, and to Mr. A. L. Hughes, Emmanuel College, Cambridge, for a research on the ionization in mercury vapor produced by ultra-violet light.

THE special board for biology and geology of Cambridge University has nominated Mr. G. R. Mines, M.A., Sidney Sussex College, and Mr. H. M. Fuchs, B.A., Gonville and Caius College, to use the university table at Naples, and Mr. James Gray, B.A., King's College, to occupy the university table at the Laboratory of the Marine Biological Association at Plymouth.

PROFESSOR S. A. MITCHELL, of Columbia University, will spend a year at Yerkes Observatory.

PROFESSOR THEODORE LYMAN, of Harvard University, has gone to the Altai Mountains, on the borders of Siberia and Mongolia, on a hunting expedition. He takes with him Mr. N. Hollister, assistant curator at the National Museum, Washington, who will make zoological collections to be divided between that museum and the Harvard Museum of Comparative Zoology.

ASSOCIATE PROFESSOR FREDERICK STARR, of the University of Chicago, sailed on June 20 for Africa on an expedition for anthropological research. After a visit to Morocco and the Canary Islands, Professor Starr and his party will go directly to Liberia, and thence into the back country, where they will spend the rest of the year, returning about January 1, 1913.

DR. HERBERT MÜLLER, of the Anthropological Museum in Berlin, has gone to China for ethnological researches in Manchuria and eastern Mongolia.

MR. R. H. HOOKER, M.A., has been appointed Newmarch lecturer in statistics at University College for the session 1912–13. The subject of his lectures will be "The Food Supply of the United Kingdom."

LEONARDO DA VINCI'S contributions to the principles of aviation were celebrated in Paris on July 4, when addresses were made by the French prime minister and the Italian ambassador.

THE session of the Chemical Society, London, for 1912–13 will open on October 17 with a memorial lecture in honor of Antoine Henri Becquerel, late honorary and foreign member of the society, to be delivered by Sir Oliver Lodge, F.R.S.

MR. WILLIAM R. SMITH, for sixty years superintendent of the National Botanical Garden, died at Washington on July 7, aged eighty-four years.

PROFESSOR ORVILLE BRIGGS STACY, for forty-two years a member of the faculty of the Brooklyn Polytechnic Institute, holding the chair of natural science and mathematics at the time of his retirement in 1906, has died at the age of eighty years.

DR. THOMAS H. BACHE, great-great-grandson of Benjamin Franklin, a distinguished physician of Philadelphia, has died at the age of eighty-six years.

THE board of trustees announces that the next annual session of the American Medical Association will be held in Minneapolis from June 17 to 20, 1913.

A RECENT addition which has been made to the equipment of the Colorado School of Mines is a new 14-foot Littrow spectrograph, purchased at a cost of $1,500, through the Vinson Walsh research fund. This fund was given by the late Thomas F. Walsh for the determination and study of rare metals in ores.

A valuable collection of 117 Hawaiian birds has been presented to the University of California by Miss Annie M. Alexander, for inclusion in the California Museum of Vertebrate Zoology. The clearing of forest lands for cultivation in the Hawaiian Islands has resulted in the entire extinction of some of the species represented, so the collection is especially important.

UNIVERSITY AND EDUCATIONAL NEWS

The late Mr. C. D. Borden, of New York City, has bequeathed $250,000 to Yale University, from which he graduated in 1864. The clause in his will reads: "I make this bequest without any restrictions, as I have long been of the opinion that the said corporation did not have sufficient funds to provide adequately for its general expenses and especially for proper payment of its instructors."

Mr. John Armstrong Challoner has conveyed his property in trust, making the University of Virginia and the University of Carolina his residuary legatees, and giving $10,000 to each of nine other educational institutions.

Lord Haldane has opened the new Harrison-Hughes Engineering Laboratories at Liverpool University, erected by a gift of about £40,000 from Mr. T. F. Harrison, Mr. J. W. Hughes and Mr. Heath Harrison, the Liverpool shipowners.

It has been decided to establish a chair of agriculture in the University of Queensland, toward which Mr. Robert Philp has offered to give £1,400 and Mr. R. M. Christison £1,000.

Mr. Walter Morrison, of Baliol College, has given £10,000 to Oxford University for the promotion of the study of agriculture.

The late Dr. A. W. Verrall, King Edward VII. professor of English literature at Cambridge, left, subject to the life interest of his wife, £1,000 to the university absolutely, and £1,000 to Trinity College absolutely.

An addition is being made to the Agricultural Building of the University of Illinois by enclosing the court. The structure will be only one story high and will have cement floors. It will provide reading room, class rooms, museum, etc.

The Medical School of Trinity College, Dublin, celebrated the bicentennial of its foundation on July 5. Seventy-eight addresses were presented by delegates from other institutions.

Dr. Robert Sharp, dean of the graduate department of Tulane University, has been elected acting president of the university, succeeding Dr. Edwin B. Craighead, who recently resigned to become president of the University of Montana.

Dr. William Pepper, professor of clinical pathology at the University of Pennsylvania, son of the former provost of the university, has been appointed dean of the Medical Department, to succeed Dr. Allen J. Smith, resigned. Dr. Smith will remain professor of pathology, comparative pathology and tropical medicine.

Dr. Thomas F. Hunt, director of the School of Agriculture of the Pennsylvania State College, has been appointed to succeed Dr. E. J. Erickson, dean of the College of Agriculture of the University of California.

Dr. Arthur I. Kendall, Boston, has been placed in charge of the research work on tuberculosis in Northwestern University, the chair for which was recently endowed with $250,000 by James A. Patten, Evanston, Ill.

E. N. Zern, recently professor of coal mining at the University of Pittsburgh, has been appointed professor of mining at West Virginia University, Morgantown, W. Va.

Ansel F. Hemenway, of the University of Chicago, has been appointed professor of biology and geology at Transylvania University, Lexington, Ky.

Dr. Otto Glaser has been promoted from an assistant professorship in zoology to the rank of junior professor at the University of Michigan, and has been granted $275 for equipment for his studies on the energetics of embryogenesis.

The following appointments have recently been made to the faculty of the College of Agriculture, University of Porto Rico: Mr. C.

L. Lang, professor of mathematics and physics; Mr. W. Ramirez, professor of Spanish; Miss E. Prat, instructor in biology.

THE Agricultural College of Utah announces the organization of a course in agricultural engineering with departments of irrigation and drainage, road building, farm machinery, farm buildings, hydraulics, rural sanitation and public health. The following appointments to the faculty have been made: R. B. West, C.E. (Cornell), professor of engineering, and Frank Daines, A.M. (Harvard), professor of history, to succeed Professor Harrison Dale, who has accepted a similar position in the Washington University at St. Louis.

THE Syracuse University Medical School has called the following men to its corps of instruction: as assistant professor of bacteriology, Leverett Dale Bristol, A.B., M.D. (Johns Hopkins), of St. Paul, Minn.; as instructor in the department of histology, Earl V. Sweet, A.B., M.D. (Cornell), of Phœnix, N. Y.; as instructor in surgery, Albert G. Swift, M.D. (Syracuse), of New York City; as instructor in pathology, John W. Cox, M.D. (Syracuse). This position was secured by scholarship. At the suggestion of the dean, Colgate University has signified its intention of permitting students to take the senior year in a registered medical college *in absentia*, such students to receive the bachelor's degree upon the presentation of a certificate from the college of medicine attended to the effect that his work has been done satisfactorily.

DR. H. K. ANDERSON, F.R.S., fellow of Gonville and Caius College, Cambridge, known for his research on the physiology of the nervous system, has been elected master of the college, in succession to the late Rev. E. S. Roberts.

MISS JANET LANE-CLAYPON, M.D., D.Sc. (London), lecturer in hygiene and physiology at Battersea polytechnic, has been appointed lecturer in hygiene and physiology at King's College for Women, London.

THE following appointments have been made at the University of Manchester: Richardson lecturer in mathematics, Mr. W. D. Evans, M.A., now lecturer in mathematics at Hartley College, Southampton; junior assistant lecturer in physics, Mr. Harold Robinson, B.Sc.; demonstrators in anatomy, Mr. J. B. Stopford, M.B., and Mr. Manfred Moritz.

DISCUSSION AND CORRESPONDENCE

PHILIPPINE SHARKS

TO THE EDITOR OF SCIENCE: I have just received two memoirs on Philippine sharks by Dr. H. M. Smith.[1] In the first of these *Pentanchus profundicolus* is described as a new genus and species, and the representative of a new family of Notidanoids; in my opinion this fish belongs to the family Scyliorhinidæ, and if, as I suspect may be the case, the absence of the first dorsal fin is abnormal or accidental, it is a *Scyliorhinus* closely related to the species numbered 11 to 14 in my synopsis.[2] The second paper deals with the Squalidæ, and on comparing with my synopsis[3] I find that the new genus *Nasisqualus* corresponds to a section of *Centrophorus* which has already received the names *Acanthidium* and *Deania;* a second new genus, *Squalidus*, is valid, differing from *Euprotomicrus* in the structure and position of the first dorsal fin.

C. TATE REGAN

BRITISH MUSEUM (NATURAL HISTORY)

ARAGONITE COATING GRAVEL PEBBLES

TO THE EDITOR OF SCIENCE: On a trip to Clinton, Massachusetts, with Professor George H. Barton, I found in a gravel pit, directly opposite the station, a number of large pebbles with the white coating of calcium carbonate that one often sees. A hemispherical radiate growth up to 5 mm. long, at certain points, attracted my attention, and I took a couple of pebbles home. The coating, to my great surprise, proved both by Meigen's test with cobalt nitrate and by optical tests (-ex. o cleavage parallel elongation) to be aragonite.

Though I have made no goniometer investigation, the divergent prismatic crystals with

[1] *Proc. U. S. Nat. Mus.*, XII., 1912.
[2] *Ann. Mag. Nat. Hist.* (8), I., 1908, p. 453.
[3] *Ann. Mag. Nat. Hist.* (8), II., 1908, p. 39.

striated ends appear to be bounded by *b*, *m* and *k*, as well as other faces.

I am now wondering how commonly such coatings are aragonite rather than calcite.

Alfred C. Lane

Tufts College, Mass.,
June 18, 1912

SCIENTIFIC BOOKS

Theoretical and Physical Chemistry. By S. Lawrence Bigelow, Ph.D., Professor of General and Physical Chemistry in the University of Michigan. New York, The Century Co. 1912. 14 × 22 cm. Pp. xiii + 544. Price $3.00.

In his preface, the author points out that, after gaining some knowledge of the facts in the first year or two's study of chemistry, students are ready to find both profit and pleasure in a more philosophical study of generalizations and principles than was possible at an earlier stage. Truly, the modern beginners' course in general chemistry, although it is in part descriptive and detailed, yet fully deserves the appelation "general" in Ostwald's sense, and might well have served for a course in physical chemistry some fifteen years ago (p. 4). Selecting the generalizations from the masses of details accumulated in all the special branches of chemistry, however, "our subject makes a specialty of these generalizations," and therefore stands to chemistry in the same relation as philosophy does to all sciences. Instead of "Theoretical and Physical Chemistry," the book might, indeed, have well been entitled "The Philosophy of Chemistry," if for no other reason because of the catholic and philosophic viewpoint of its author. After reading his prefatory acknowledgments to his former teachers Ostwald and Nernst, one looks rather for Germanic philosophy; but what one finds is Anglo-Saxon. For those who require to have this distinction characterized for purposes of physical science it may be stated, with Duhem, that the Anglo-Saxon temperament wishes to construct a tangible model of sticks and strings, while the Germanic carries the logic to its necessary conclusion, however unfathomable.

In regard to the subjects treated, any criticisms as to omissions is disarmed by the statement that "the most difficult part of the task has been the selection of topics to omit." In spite of well-chosen omissions, however, a very wide field is nevertheless covered, lightly, often with elegance and always with clearness. The titles of some of the thirty chapters which the book contains are as follows: The Scientific Method; Fundamental Definitions; Unit Quantities of Chemistry and Chemical Notation; Chemical Energy, Affinity and Valence; Spectroscopic Evidences and the Theory of Inorganic Evolution; Luminiferous Ether and Vortex Rings; Radioactivity and the Electron Theory; Solid Solutions; Colloidal Solutions; Liquefaction of Gases; Some Elementary Thermodynamic Deductions; Actinochemistry. In an elementary text, beaten tracks have, in the main, to be followed, for "classifications and methods of presentation which have proved satisfactory by their results should not be tampered with unless for clearly good cause. My colleagues will therefore recognize many familiar statements and arrangements in the following pages"—which remark again disarms criticism of the author, at least, for an occasional misstatement. Examples of the side-heads to paragraphs may serve to show that the topics selected for treatment are not by any means identical with those common to other similar text-books; such side-heads are: Relativity Principle, Table of Energies and their Factors, Landolt's Experiments, Significance of Valence, Archimedes Spiral [of the elements], Protyle, Emission of Light and Temperature, Stefan's Law, Bolometer, Proto-elements, Zeeman Effect, Canal Rays, The Value of e/m, Stokes' Law, Siendentopf and Zsigmondy's Results, Brownian Movement, Kundt's Method, "Etch Figures," Agglutination, Three Ways to Damage a Storage Cell, etc. The paragraph on page 141 on the deduction of Avogadro's theory might, by the way, be omitted or modified in the light of Rayleigh's note on page 326 of Maxwell's "Heat."

After all, the manner, in an elementary text, is perhaps even more important than the mat-

ter. Preeminently throughout, the manner is one of friendliness to the student; and, as one reads, one senses constantly the author's mental attitude of regret that our accepted terminology has been confusing or that the subject can not be made even plainer than a pike-staff. In the preface we read, ". . . most earnest efforts have been directed to show the inherent simplicity of some ideas . . ."; and it may truly be said that these efforts have been, in the main, remarkably successful.

The publishers have done their work well, and the book is excellently produced and unusually free from *errata*. There can be no doubt that this is the best text-book in its range and field that has yet appeared.

ALAN W. C. MENZIES

In Northern Labrador. By WILLIAM BROOKS CABOT. R. G. Badger. Illustrated. $2.50.
Among the Eskimos of Labrador. By S. K. HUTTON. J. B. Lippincott Co. Illustrated $3.50.

These are two notable books about a little-known country, which give valuable and interesting information as to the life conditions and the racial characteristics of its aboriginal peoples. The interesting volume by the American regarding the Indians of the central inland district is well balanced and supplemented by the English doctor's detailed accounts of the Eskimos of the northern coasts.

Most readers will find specially attractive the well-written, beautifully illustrated volume by Mr. Cabot, who prefaces his experiences by a brief, admirable summary of previous explorations. While he has many times visited Labrador the book confines itself to accounts of five visits, wherein he acquired some facility in Indian speech, and became familiar with the social, domestic, travel and hunting methods of both the Eskimo and Indians.

He outlines Grenfell's great work in a sentence: "He represents the modern humanities on a coast where before they were peculiarly lacking." With artistic appreciation he writes: "The bergs are gigantic crystalline masses, pure elemental separations, the like of which neither land nor sea has to show in any other form. In some lingers the greater design, foundation, plinth and shaft. The gods of the North had their temples and these are their fragments." Vegetation and landscape, birds and beasts, fish and mankind all appeal to his observing mind.

The illustrations from photographs are excellent, and well chosen, adequately representing the land and the people.

The data obtained on Lake Mistinipi, an affluent of George River, as to the Naskapi Indians are valuable. Tersely they are described as untamed aborigines, of the stone age, of unmodified raciality, thin-legged, wiry, with horse-tail hair. The typical photographs and ethnographic details are of special interest.

The appendix on mice will be read by scientists with pleasure. His remarks, on the intimate interrelations between the humbler forms of life and seasons of want and plenty for the higher forms, will be noted with interest. The volume is a welcome addition to our knowledge of this inhospitable land.

Dr. Hutton's hospital service of five years among the eskimos of extreme northern Labrador has enabled him to produce quite a remarkable book. With these aborigines he has "come in closest contact in their homes, in their work, in their hunting and their journeys, in health and in sickness." More than thirty reproductions of photographs, with notes, afford clear ideas of the features, dress, and life conditions of these Children of the Ice. There are interesting descriptions of weddings, seal-hunting, walrus-killing, fur-trapping, reindeer-hunting, tent and igloo life, child training, etc. An adventurous touch is given in a sledge journey wherein the author was lost on a mountain-crossing, in a violent snow storm. In short the volume is filled with information as to the present condition of the eskimos of Labrador that will be most acceptable not only to the general reader, but to ethnologists. Specially noteworthy is the account of the semi-heathen natives of Killinek, the most northerly point of Labrador, with its decrepit old chief, Tuglavi.

The Killineks "are more weather-beaten than those farther south, as they live mainly

in snow-huts and tents, without fires, cheerfully enduring the most terrible climate imaginable." They are gradually coming under missionary influences, to their marked benefit.

It is pleasant to know from such authority that the eskimos of Labrador are living cleanly and under moral conditions, that they have elected elders who control quietly and effectively the whole community. Crime is practically unknown, and the success in banishing liquor-making is a notable instance of their power of self-government. Most persons will be surprised to learn that in literacy the eskimos of Labrador surpass the people of the United States, for, we are told, every eskimo child above twelve years of age can read and write. Every year an eskimo paper is published, and from time to time pamphlets, etc., in the native dialect. They are "a kindly, hospitable people, quick to anger and quick to forgive." The Moravian missionaries have wisely urged the continuance of native methods as to dress, customs and food.

Altogether these two volumes are among the most valuable that have appeared relative to American aborigines in several years.

A. W. Greely

Reminiscences of the Yukon. By the Hon. Stratford Tollemache. Longmans, Green and Co. Illustrated. $3.50 net.

The Conquest of the Great Northwest. By Agnes C. Laut. New ed. 2 vols. in one. Moffat, Yard and Co.

The new and cheaper edition of the "Conquest of the Great Northwest" will be most acceptable to the many desirous of possessing this vividly told story of the Hudson Bay Company, with the preliminary voyages of Henry Hudson, and the rise of the opposition Northwest Company.

The passing of the Hudson Bay Company, and the supplanting of its fur-trade by the gold-seekers of the Yukon Valley, naturally transformed the economical and human history of northwest arctic America. Well told as it is, few now take special interest in the account of the Klondike rush in 1898, the upbuilding of Dawson, and the extension of gold discoveries in adjacent regions. These events marked an epoch that has been told and retold in many scores of volumes.

Mr. Tollemache has, however, made a most acceptable addition to life in the Yukon in his reminiscences of eleven years of frontier existence. His experiences on the Pelly and McMillan rivers as a trapper cover a phase of frontier life of which little has been published. His accounts of the methods followed in trapping, and remarks on the game of the country —fish, fowl and beast—are contributions to an accurate knowledge of the natural history of the Yukon watershed that will be eagerly read.

Probably the most interesting chapter in the volume, certainly so to scientists, is that on color protection and big game, though a disappointingly small part is devoted to the color scheme. The account of the Indians is discouraging to the well-wishers of the aborigines, but doubtless correct in its general features. The illustrations are of interest in their presenting methods of trapping with which most general readers are unfamiliar.

A. W. Greely

Sewage Disposal. By George W. Fuller. New York, McGraw-Hill Book Co. 1912. Pp. 767.

This book is, according to the author's preface, a resumé of the progress that has been made in this country during the last quarter century by one who has been intimately associated with the work. No one could be better qualified to write such a book than Mr. Fuller and no better book on the subject has been written. Its nearly eight hundred pages make a very formidable document, but the dismay of the reader will vanish when he discovers that the material is excellently arranged, clearly printed and paragraphed, and well indexed. Brevity has been sacrificed to clearness, and repetition has been employed for the sake of emphasis. The principal reason for the size of the book, however, is that the author has, as he says, drawn fully from the writings of others and from the professional papers and reports of the firm of

which he was so long a member. Some might have wished these quotations to have been abstracted and condensed, but most engineers will very much appreciate having so many important works set forth in such a convenient form for reference. While the author has quoted largely he has not failed to express his own ideas on most questions at issue. On matters of doubt he has set forth the arguments and opinions of experts on both sides.

Perhaps the most commendable feature of Mr. Fuller's book is his point of view. It is not a mere description of methods used for attempting to purify sewage, it is far broader than that. This is shown by the fact that fully half of the book is devoted to the composition of sewage, its decomposition, sewage bacteria and the disposal of sewage without treatment into inland streams, lakes and tidal estuaries. It is again shown by the use of the term "sewage treatment" in place of the misused and very misleading term "sewage purification." This change the reviewer heartily approves and believes that it alone will do much to place the matter of sewage disposal in the right light for those who are interested in the subject from a sanitary standpoint only. The sooner that the medical fraternity and the health officers realize the limitations in the sanitary efficiencies of some of the processes of treatment employed, the more rapid will be the rational development of the art. The point of view of the author is expressed by the opening words of the sixth chapter, where he says "the disposal of sewage by treatment in works of artificial construction becomes necessary in some cases through the failure of the dilution method to meet local requirements." And again in the last chapter, where he says: "One of the most conspicuous facts to be borne in mind is that there is no standard method of procedure for the treatment of sewage, which can be uniformly applied to a large number of problems with a view to securing satisfactory hygienic results at least cost. Various partial methods, arrangements or devices are suitable in some combination or another for a large number of problems. But there is no cure-all or appliance which can be installed for all problems. Each set of local conditions should be carefully studied, in order to secure proper hygienic efficiency with due regard for economy of construction and operation, before new works are adopted, or extensions made to existing works."

Another good feature of the work is its historical point of view. The reader can not fail to be impressed with the fact that the art of sewage treatment has been a gradual evolution of methods to fit particular conditions and that there are yet many problems to be solved. Nor can he fail to observe how the advances in scientific thought in the realm of bacteriology and physical chemistry are profoundly affecting actual practise. An entire chapter is devoted to the development of experiment stations and a table is given showing that during the last twenty-five years nearly $900,000 has been spent in this country for experimental studies relating to the purification of water and sewage. Especial tribute is paid to the pioneer researches of the Massachusetts State Board of Health Experiment Station at Lawrence. The historical aspect of the book is well shown in the treatment of the problem of sewage disposal in the harbors of Boston and New York.

It is probable that the first half of the book, in which the more general aspect of the disposal of sewage by dilution is considered, will be more appreciated by engineers than the second half, devoted to methods of treatment, for the reason that data regarding the former subject have never before been so thoroughly compiled. The layman, however, will derive benefit from the systematic descriptions of processes in the second half of the book.

To describe the book more specifically, there are twenty-six chapters, devoted to the following subjects: Composition of Sewage; Aerobic and Anaerobic Decomposition of Sewage; Sewage Bacteria as Related to Offensive Odors; Sewage Bacteria as Related to Public Water Supplies; Sewage as Related to Shellfish; the Problem of Sewage Disposal; Experimental Methods as Applied to Sewage Disposal Problems; Dilution in Inland

Streams; Dilution in Large Lakes; Dilution in Oceans and Tidal Estuaries; Sewage Treatment Works; Screening; Plain Sedimentation; Septicization in Connection with Sedimentation; Chemical Precipitation in Conjunction with Sedimentation; Electrolytic Treatment; Strainers, Slate Beds and Colloidors; Broad Irrigation; Intermittent Sand Filtration; Contact Filters; Sprinkling Filters; Aeration; Hypochlorite Treatment; Ozonization; Institutional and Residential Plants; Comparative Summary.

It will be noticed that some of the newer processes, such as ozonization, the use of electrolytically prepared hypochlorite, etc., are also gone into, but with reservations as to their probable utility. In the description of processes, emphasis has been placed on the underlying principles and on the efficiencies obtained by their application, while structures have been described only to a limited extent and the illustrations are relatively meager, The subject of cost is also one that has not been elaborated.

George C. Whipple

SCIENTIFIC JOURNALS AND ARTICLES

The contents of the *American Journal of Science* for July are:

"Storm King Crossing of the Hudson River, by the New Catskill Aqueduct, of New York City," J. F. Kemp.

"Lake Parinacochas and the Composition of its Water," G. S. Jamieson and H. Bingham.

"Shell Heaps of Maine," F. B. Loomis and D. B. Young.

"Mixtures of Amorphous Sulphur and Selenium as Immersion Media for the Determination of High Refractive Indices with the Microscope," H. E. Merwin and E. S. Larsen.

"Asymmetry in the Distribution of Secondary Cathode Rays produced by X-rays; and its Dependence on the Penetrating Power of the Exciting Rays," C. D. Cooksey.

"Derivation of the Fundamental Relations of Electrodynamics from those of Electrostatics," L. Page.

"Hydrolysis of Esters of Substituted Aliphatic Acids," W. A. Drushell.

"Some Suggested New Physiographic Terms," DeL. D. Cairnes.

The following articles are printed in the *Journal of Genetics* for June:

"Species Hybrids of *Digitalis*," W. Neilson Jones.

"Notes on Inheritance of Color and other Characters in Pigeons," L. Doncaster.

"On Heterochromia Iridis in Man and Animals from the Genetic Point of View," C. J. Bond.

"Second Report on the Inheritance of Color in Pigeons, together with an Account of some Experiments on the Crossing of certain Races of Doves, with special reference to Sex-limited Inheritance," Richard Staples-Browne.

"Gigantism in *Primula sinensis*," Frederick Keeble.

RECENT WORK IN SYSTEMATIC AGROSTOLOGY

Beiträge zur Gramineenflora von Misiones: E. L. Ekman (*Arkiv f. Botanik,* 11: no. 4. 1912).

The author visited for three months in 1907–08, Misiones, that portion of Argentina lying between Uruguay and Paraguay. The above article is a critical account of the grasses collected at this time. The author enumerates 125 species and gives a table showing the relation of these to the surrounding regions. The larger genera are *Panicum* 27 species (23 species as the genus is limited by Hitchcock and Chase), *Paspalum* 19 species and *Andropogon* 14 species (including *Sorghum, Sorghastrum* and *Heteropogon*). There are four beautiful plates, taken from photographs, by the gelatin process, and illustrating the inflorescence, the details of which are excellently shown. The work inspires confidence from the incorporation of numerous critical notes. It is interesting to note that the anomalous *Leptochloa spicata* is transferred to the genus *Tripogon,* a disposition which is well supported by evidence. The descriptions of new species are in Latin, the notes in German.

The Grama Grasses: David Griffiths (*Contr. Nat. Herb.,* 14: 343–428, 1912).

This was reviewed recently by Dr. Bessey[1]

[1] Science, April 12, 1912, p. 590.

and here may be added only a few agrostological notes. The pen-and-ink drawings by Agnes Chase, illustrating the details of the spikelet, are accurate and particularly helpful in a group having so complicated a floral structure. The half-tones from photographs by the author illustrating the habit are unusually good. The genus *Cathestecum*, placed in the tribe Zoysiæ by Bentham & Hooker and in Festuceæ by Hackel (Engl. & Prantl, Pflanzenfam.) is here considered to be a close ally of *Bouteloua*, a conclusion well supported by the structure of the spikelets, as shown by the illustrations. The name *Bouteloua* is used rather than the older spelling *Botelua*. This suggests the desirability of adopting a definite rule to govern such cases. Lagasca deliberately adopted *Botelua* in 1805, using this spelling throughout his article, but in 1816 changed this to *Bouteloua*, which spelling has been used by all later authors. Lagasca states that the genus was named for the brothers Boutelou. I have used Lagasca's corrected spelling myself, but there is a tendency at present to subject even the spelling of generic and specific names to the law of priority. There are several changes in the names of familiar species. *Bouteloua procumbens* (Durand) Griffiths, for *B. prostrata* Lag.; *B. gracilis* (H. B. K.) Lag., for *B. oligostachya* Torr.; *B. barbata* Lag., for *B. polystachya* (Benth.) Torr.; *B. trinii* (Fourn.) Griffiths, for *B. trifida* Thurb. and *B. burkii* Scribn. On technical grounds, the name *Bouteloua bromoides* disappears altogether. In place of this we have *B. filiformis* (Fourn.) Griffiths, and two allied species, *B. radicosa* (Fourn.) Griffiths and *B. repens* (H. B. K.) Scribn. & Merr. Dr. Griffiths accepts 1881 as the date of publication of Fournier's work on "Mexican Grasses." The title-page date is 1886, but at least two copies of press-proofs were distributed in 1881 and used by Bentham and by Hackel as if published. By admitting the earlier date the author is obliged to take up *Chondrosium trinii* Fourn. which antedates both *Bouteloua trifida* Thurb. (1883) and *B. burkii* Scribn. (1883).

Plants of Southern New Jersey: WITMER STONE (*Ann. Rep. N. J. State Mus.*, 1910).

The title page date of issue is 1911, but the volume did not reach us until February, 1912. Reference will be made here only to the portion relating to the Gramineæ (pp. 174–246, pls. 5–15). As to form, the work is a model for its class. Though no descriptions are given, there are excellent keys to genera and to species. There are also important notes upon habit and local distribution. The half-tone plates illustrating the inflorescence are unusually good. In the recent revision of *Panicum* by Hitchcock and Chase many interesting northern extensions of the range of species to New Jersey are based upon Mr. Stone's collections, such as that of *P. wrightianum*. This species has since been collected on Cape Cod by E. W. Sinnott, and by Clarence Knowlton. I wish to criticize a method in technique adopted by the author. In this I do not wish to criticize Mr. Stone, because he has ample precedent for the method used. It is the citation of names in synonymy in such a manner that the reference appears to be the original publication when in reality it is to a later work or to a work in which the name has been misapplied. For example, "*Panicum sphagnicola* Nash, Brit. Man. Ed. I. 85." is given under *Panicum lucidum* Ashe. The original publication of *P. sphagnicola* was several years earlier (*Bull. Torrey Club*, 22: 422. 1895). The author means by his reference that *P. lucidum* was described under the name *P. sphagnicola* in Britton's Manual. Apparently Mr. Stone has intended to distinguish the original place of publication by giving the citation in full with date. But under *Tripsacum* we see as the second name in the list of synonyms, "*Tripsacum dactyloides* Nuttall Gen. I. 85. 1818," although the name was first published by Linnæus ("Syst. Nat.," ed. 10: 1261. 1759). This is not an error on Mr. Stone's part, as is shown by the accepted name at the heading where "L." is given as the authority. Mr. Stone probably inserted the Nuttall reference because of a note there on the local flora.

Erianthus alopecuroides "Gray Man. Ed. I. 616. 1848," appears as a synonym under *E. saccharoides,* though the original author of the former was Elliot in 1816. This method of citation lacks precision. On seeing the above citation one might justly infer that Gray's Manual is the original place of publication of *Erianthus alopecuroides.* This, however, is not the idea the author wished to convey. What he does mean is that in Gray's Manual the name *E. alopecuroides* Ell. was erroneously applied to *E. saccharoides.* Authors have recognized this lack of definiteness and have attempted in various ways to avoid it. Some would write the reference *E. alopecuroides* "Ell.," Gray Man. 616. 1848. Others, *E. alopecuroides* Ell. err. det. Gray (cf. Piper, "Flora of Washington," Contr. Nat. Herb., Vol. 11). I have used this, *E. alopecuroides* [Ell. misapplied by] Gray, Man. Some would place original references in one category and misapplications and secondary references in another, or make a statement in a note that Gray (Man. 616) described this species under *E. alopecuroides* Ell. I do not wish here to recommend especially any of the above methods, but only to insist on the necessity of distinguishing between the two categories of citations, publication and misapplication.

Mr. Stone has used for the citation of authors the method rather generally adopted by zoologists, in which only one author is given and that one the author of the specific name. The great majority of botanists cite at least the author of the accepted combination of genus and species, and often also the author of the specific name if published originally under a different genus. Under *Uniola* we find *Uniola laxa* (L.), showing that Linnæus gave the specific name *laxa* under a different genus. In the list of synonyms given by Mr. Stone we see that Linnæus described the species as *Holcus laxus.* In the list of synonyms also appears *Uniola laxa* Britton 294, but this is only a reference to localities given in Britton's "Catalogue of Plants of New Jersey" (I had some difficulty in determining the meaning of this reference), and not to the original publication of the combination (B. S. P. Prel. Cat. N. Y. 69. 1888). It happens that Mr. Stone has made certain combinations for the first time and hence will be cited by most botanical writers as the author of these combinations. But there is no means of determining which of the combinations are new, except by the laborious comparison of each case, since the combination may not appear in the list of synonyms, or if it does the reference may be misleading in this respect. Of course this omission is of no consequence to those who use the zoological method of citation. Mr. Stone probably did not realize the additional difficulties he was placing in the way of the indexer when he decided to omit all indications by which the new combinations could be distinguished. Among the grasses the following new combinations are made: *Paspalum læve circulare* (Nash) Stone, *Panicum commonsianum addisonii* (Nash) Stone, *Chætochloa imberbis versicolor* (Bicknell) Stone.

It is to be noted that Mr. Stone gives the original place of publication of *Panicum stipitatum* Nash, as Britton's Manual 83. The name was first used by Scribner (U. S. Dept. Agr. Div. Agrost. Bull. 17 (ed. 2): 56. May, 1901) where it is credited to "Nash, in Britt. Manual, 83, 1901." This must have been taken from proof sheets, as Britton's Manual did not appear till after August 24, 1901 (the date of the preface). This is mentioned only in reference to the question of the standing of proof sheets as publication.

As previously stated, these remarks are not intended as a criticism of Mr. Stone or of the excellent flora which he has published. The work suggested the remarks and this opportunity was taken to record certain protests.

Notes on Genera of Paniceæ: Agnes Chase (*Proc. Biol. Soc. Washington,* 19: 183–192, 21: 1–10, 21: 175–188, 24: 103–160).

It has long been recognized by agrostologists that the classification of the genera of grasses is still very artificial and greatly needs revision. Botanists who have turned their attention to this family have been kept

busy with the classification of the species and very little has been done with the genera since the exposition by Bentham and Hooker (Gen. Pl. 3^2. 1883) and by Hackel (Engl. & Prantl, Pflanzenfam. 2^2. 1887). It is true that authors have attempted revisions of genera in local floras, recognizing the necessity of rearranging groups to accord with additional facts. But too often such rearrangement has been based solely upon species growing within the region covered by the flora. Nature knows no such limitations. Groups that are perfectly distinct in one area may in another area be connected by transition forms. Mrs. Chase has begun the revision of the genera of the entire family throughout the world. The four papers mentioned deal with the tribe Paniceæ, which will be completed in one more paper. The genera still to be discussed belong to the subdivision of the tribe in which the spikelets are surrounded by bristles. Under each genus is given a full discussion of the synonymy, a description of the genus as limited by the author, and, in American genera, an excellent text figure of the spikelet drawn from the type species. The author has been consistent in recognizing genera, basing validity upon characters of the same kind and degree. Such classification is necessarily the result of her botanical judgment, but this judgment is based upon a careful comparison of characters of the group as represented throughout the world, and unbiased by tradition or authority. Those who have given only superficial attention to grasses, and to whom certain names have become familiar, will "view with alarm" the splitting up of such genera as the heterogeneous *Panicum*. But a close study must convince the most conservative that the great genera *Panicum* (in the restricted sense) and *Paspalum*, recognized as distinct since their separation by Linnæus, are more closely allied than any of the segregates from *Panicum* recognized by Mrs. Chase, such as *Syntherisma* (*Digitaria*). In fact in the excellent synoptical key to genera, appearing in Part IV., *Valota* (*Panicum leucophæum*), *Syntherisma* and *Leptoloma* (*Panicum cognatum*) are numbered 3, 4 and 5, while *Panicum* and *Paspalum* are numbered 16 and 17. The author quite properly revises the nomenclature of the species in each genus in so far as this can be done without a further study of type specimens. Much just criticism has been directed against what some have been pleased to call "name-juggling," a sort of pop-gun revision, in which the primary purpose has been to change names or create new combinations. The nomenclature of a group of plants should be revised by the person who revises the taxonomy. And nomenclature in its applications should not be considered apart from the study of the plants involved. Mrs. Chase, however, has given the taxonomy careful study and is in position to adjust the nomenclature. It is hoped that the other tribes of grasses may be revised by her in the same manner.

North American Flora. Poaceæ: G. V. NASH (*N. A. Fl.* 17: 77–98. 1909).

In this number only a beginning is made, including a key to the thirteen tribes, and descriptions of the first 18 genera, up to and including *Elionurus*. The form of treatment is fixed by the general style of the work, for which reason certain criticisms must be shared by the editors. But the style adopted by the editors is the result of definite consideration and any criticism of this must take the form of a protest or regret. Probably the omission that the student will most often regret is the lack of cited specimens. To the student of grasses the mention of a few selected specimens might well take the place of the plates listed. It is also to be regretted that room could not be found for critical notes on synonymy. It is a good idea to give the type species of each genus, but there will be many cases where selection must be made and it would be helpful if the reasons for a certain choice were given. In *Hemarthria* the first of two species was chosen. In *Miscanthus* the second species is chosen. The reason for rejecting the first species is a good one, namely, because Andersson, the author of the genus, remarks that the first species, *M. capensis*, shows a transition to other genera, but it would be more satisfactory to the student if

this reason were given. It will be interesting to note the manner in which Mr. Nash in the future parts of the work solves the various difficulties which will beset him in fixing the types of the genera.

The name *Tripsacum acutiflorum* Fourn. (*Bull. Soc. Bot. Belg.* 15: 466. 1876) is accepted in place of *T. lanceolatum* Rupr. (Fourn. Mex. Pl. 2: 68. 1881). This is based upon the statement made by Fournier, in a discussion of grasses with separated sexes, that in *Tripsacum* the peduncle of the male spikelet, ordinarily free, "est soudé avec le rachis de l'épi dans le *T. acutiflorum* n. sp." This statement certainly does not distinguish *T. lanceolatum* from the other species and can scarcely, therefore, be considered as sufficient to constitute publication. It is rather to be taken as incidental mention within the meaning of the American Code of Botanical Nomenclature (Canon 12. A name is not published by its citation in synonymy, or by incidental mention). The allies of *Rottbœllia cylindrica* have difficulty in keeping their names. When Otto Kuntze showed that the type species of *Manisuris* was a *Rottbœllia,* the names of these species were changed from *Rottbœllia* to *Manisuris.* Now Mr. Nash decides that this group is not congeneric with the type of *Manisuris,* but belongs to the genus *Stegosia* and the species are all transferred to the new allegiance. At the same time that Kuntze made the disconcerting discovery mentioned above he found it necessary to change the name of the grass generally called *Manisuris granularis,* since it obviously was not a true *Manisuris.* He called it *Hackelochloa granularis,* and is followed in this by Mr. Nash (and also by the present writer. See "Grasses of Cuba"). However, it appears necessary to take up for this genus the name *Rytilix* Raf. (*Bull. Bot. Seringe,* 1: 219. 1830).

While Mr. Nash's contribution is not, and could not be expected to be, monographic, it will be, when completed, of great service to agrostologists.

A. S. Hitchcock

SPECIAL ARTICLES

RHYTHMICAL ACTIVITY OF ISOLATED HEART MUSCLE CELLS IN VITRO

In previous communications[1,2] I pointed out that the heart muscle of chick embryos will beat rhythmically for many days when suspended in the media of a tissue culture and from such transplanted tissue there is an active growth of cells into the surrounding media. Braus[3] has repeated these experiments, using the hearts of embryo frogs and toads and he has found that these isolated beating hearts react to electrical and chemical stimuli similar to the intact heart. Braus also noted that the cells which grew from the hearts of cold-blooded animals were living at the end of three months. Very recently, Carrel[4] by the use of the method of repeated transplantation of the tissue from a culture to a fresh medium (Carrel and Burrows) has attempted to prolong the life and function of heart muscle *in vitro.* His experiments show that the rhythm which I noted in fragments of embryonic chick hearts can be prolonged, although intermittently, for a period of 85 days. The results of these experiments substantiate, therefore, the former well-known fact, namely, that strips of heart muscle, both of cold and warm blooded animals (Erlanger), will beat for some time when placed in the proper media. In none of these cases could one rule out, however, the possibility of the existence of nerve ganglia or some possible precursor in the young embryonic hearts, which might initiate rhythmical contractions.

During the present year experiments have been made to determine the conditions which would prolong the life and allow the development of functional activity in the cells which had grown and differentiated in the culture.

[1] Burrows, M. T., 1911, *Jour. Exp. Zool.,* Vol. 10, 63.

[2] Burrows, M. T., 1912, *Anat. Record,* Vol. 6, 141.

[3] Braus, H., 1912, *Weiner Med. Wochschr.,* No. 44.

[4] Carrel, A., 1912, *Jour. Exp. Med.,* Vol. XV., 516.

These experiments have shown that the newly grown, cellular syncytia and the isolated single heart muscle cell can become functionally active, beating with a rhythm similar to that of the intact heart.

Pieces of the hearts of chick-embryos of all ages and of young hatched chickens were used. A growth of tissue, composed almost entirely of muscle cells, occurred from all pieces when suspended in the media of both types of cultures, (1) the ordinary hanging drop culture (the plasma modification[1]) of the method of Harrison[5] and (2) a large modified type of culture. This apparatus is so arranged as to supply the tissues continuously with fresh media and to wash away the waste products without in any way disturbing the growing cells. I described this method in detail before the American Association of Anatomists, December 27, 1911.[2] Serum was used as the fluid medium in the latter type of culture.

Rhythmical activity of the newly grown cells was noted in 3 out of 15 of the large type of cultures (No. 2), and in 2 out of 150 of the ordinary hanging drop cultures. These cells were located definitely within the clot and had a clear cytoplasm which contained very few fat droplets. The rhythmical activity did not occur during the active outwandering of the cells but, later, after they became permanently located in a definite portion of the clot and were undergoing slow multiplication and differentiation. In one culture rhythm occurred as early as the fifth day, while in others as late as the fourteenth day of the life of the culture. The greater number of positive results in the large type of culture (No. 2) can be associated with the active and continuous growth of the tissue over a sufficient period of time. Active growth and a regular rhythm has been observed in these cultures for 30 days, while in the hanging drop culture the active growth and the regular rhythm cease after the third or fourth day. The growth then becomes gradually less and the rhythm intermittent, ceasing entirely after 10 or 18 days unless the tissue is transferred to a new medium. The method of repeated transplantation from the culture to a new medium has not as yet been sufficiently developed to allow any increase in the life and the activity of the newly grown cells. At each transfer of the tissue the actively growing and multiplying cells are destroyed and a new growth takes place from those more latently active cells in or about the tissue mass.

The original pieces of heart muscle transplanted to a tissue culture vary as to their rhythmical activity in relation to the portion of the heart from which they are taken as well as the age of the embryo. Pieces of the auricle, especially of that part situated near the entrance of the veins, taken from embryos of all ages and from young hatched chickens, beat when suspended in plasma. The pieces of the ventricle do not beat when taken from embryos older than 10 days, unless special methods of preparation and treatment are used.

Rhythmically beating cells have been grown from the contracting pieces of the hearts of young embryos and from one piece of the ventricle of a fourteen-day chick embryo. The absence of movement in the original mass of tissue of this culture facilitated greatly the study of the delicate contractions of the newly grown cells. The syncytial network which surrounded the original tissue and one isolated cell were beating rhythmically. This cell was situated far out in the clear medium away from all other tissues and beat with a rhythm independent in phase from that of the syncytium. The rate of all beating cells in this culture was the same, 50 to 120 per minute, or a rhythm typical for rhythmical beating pieces of ventricular muscle.

The experiments show: (1) that the cells which have grown and differentiated in a tissue culture can later assume their characteristic function; (2) that rhythmical contraction similar to that observed in the embryonic heart can occur in an isolated and single heart muscle cell; (3) that the rhythmically con-

[5] Harrison, R. G., 1907, *Proc. Soc. Exp. Biol. and Med.*, 140; 1910, *Jour. Exp. Zool.*, Vol. 9, 787.

tracting cells can be grown not only from the pieces of hearts of young embryos, but from the heart muscle of a fourteen-day chick embryo.

These experiments, therefore, give direct evidence for the myogenic theory of the heart beat.

Montrose T. Burrows, M.D.
Anatomical Laboratory,
Cornell University Medical College,
New York City

On Molecular Cohesion. A Preliminary Statement

There is much uncertainty both about the laws and nature of molecular cohesion. The attraction has been supposed to vary inversely with the square, the fourth, fifth, seventh, or even the ninth power of the distance between molecular centers; and whether cohesion is of the nature of magnetic, electric, or gravitational attraction, or whether it is of a kind of its own, is uncertain. Its relation to gravitation, on the one side, and to atomic affinity, on the other, is unknown.

1. *The Derivation of the Value a/V^2 in Van der Waals's Equation.*—The value of a/V^2 in Van der Waals's equation represents molecular cohesion. If each molecule has a mass of cohesion, M, and if the molecules attract each other inversely as the fourth power of the distance, as Sutherland suggests, then the attraction between two molecules is $M^2K/v^{4/3}$, v being the volume of one molecule. If there are $1/v^{2/3}$ molecules in a surface of one sq. cm. of a gas or liquid, the pressure per sq. cm. will be M^2K/v^2. If each molecule attracts only its neighbors, owing to the fact that the cohesion does not penetrate matter, then the internal pressure will be the same as the attraction of each double layer of molecules and instead of M^2K/v^2 we may multiply numerator and denominator by N^2, where N is the number of molecules in the volume V. This makes N^2M^2K/V^2, which is the value a/V^2 of Van der Waals's equation. It has the advantage over the usual form, a/V^2, in that the various constituents of "a" appear at once.

2. *The Latent Heat of Vaporization.*—Mills discovered the empirical relationship that the internal latent heat of vaporization divided by the difference of the cube roots of the densities of the liquid and vapor was a constant, except near the critical temperature. His equation was: $L-E_e=K(d^{1/3}-D^{1/3})$. He assumed that the internal latent heat of vaporization, or $L-E_e$, where L is the total latent heat and E_e that part of it consumed in doing external work, represented only the energy consumed in separating the molecules. He was struck by the resemblance of this equation, when transformed into $L-E_e=K'(1/v^{1/3}-1/V^{1/3})$, to that of Helmholtz representing the heat given out from the sun on contraction from the radius CR to the radius R, or $3M^2K(1/R-1/CR)/5$. The latter equation is derived by the gravitational law. Mills, therefore, concluded that the attraction of molecules must also follow the gravitational law and vary inversely as the square of the distance. The error in Mills's reasoning is the assumption that $L-E_e$ represents only the work of overcoming molecular cohesion. It represents not only this but also the heat consumed by the expansion of the molecules from their volume in the liquid to their volume in the vapor, for the molecules certainly expand on passing from the liquid to the vapor. If the heat thus consumed by molecular expansion is E_m, then since the difference in molecular cohesive energy in the vapor and liquid is $N^2M^2K(1/v-1/V)$, $L-E_e=N^2M^2K(1/v-1/V)-E_m$. Near the critical temperature E_m becomes nearly zero, and at the critical temperature this goes into the form $L-E_e=N^2M^2K(1/v-1/V)$. Since the heat rendered latent by the expansion of the molecules increases as we go downward from the critical temperature, the value $L-E_e$ must become constantly greater than $N^2M^2K(1/v-1/V)$, by the amount E_m. This is found to be the case. For example in methyl propionate $(L-E_e)/(d-D)$ has the following values in absolute units taking gram mol quantities:

Temperature	$(L-E)/(d-D)$	N^2M^2K/Wt
100°	3.417×10^{11}	
200°	3.030	

250°	2.598	
256°	2.396	
257°.4 (critical)		2.353×10^{11}

The fact that Mills's equation gives a constant is, then, rather evidence against the hypothesis that the attraction is inversely as the square of the distance, instead of in favor of that hypothesis. The real representation of the gain in molecular potential energy on passing from the liquid to the vapor is more probably, as Sutherland and others have shown, the expression $N^2M^2K/(1/v - 1/V)$, and not $K(1/v^{1/3} - V^{1/3})$. The former expression is in harmony with the conclusion that the attraction is inversely as the fourth power of the distance.

3. *The Radius of Action of the Molecules.*—The most recent calculations of the radius of action of molecules make it about 1.2 to 2×10^{-7} cm., or about two molecule diameters in the liquid state. As means of measurement have improved, the radius has shrunk. The distance between the centers of ether molecules in the liquid state at 20° is about 6×10^{-8} cm. Einstein and Sutherland have computed that the radius of action is proportional to, and very nearly equal to, the distance apart of the molecular centers. Kleeman has computed it as a little less than a molecular diameter. The only interpretation of Einstein's result is that the molecules attract only their immediate neighbors and hence, as Mills suggested, molecular cohesion does not penetrate matter. This makes it possible for the cohesion to vary inversely as the fourth power of the distance; since, if the cohesion penetrated matter like gravitation and the attraction was inversely as the fourth power, the cohesional mass is so enormously greater than the gravitational mass that the cohesional attractions of two masses would, when the masses were near, greatly surpass their gravitational attractions.

4. *Computation of the Cohesive Mass, M.*—Since the value "b" of Van der Waals's equation is not constant, but varies both with the volume and temperature, it is impossible to compute M^2K from the deviation from constancy of the pressure-volume product of a gas. M^2K may, however, be computed from the surface tension, as follows: S is the tension along a line one cm. in length and the depth of the surface film, or $fv^{1/3}$. Then $S/v^{1/3}$ is the surface tension per sq. cm. across the surface film, if the latter is one molecule deep, as it probably is at absolute zero, for which temperature the final computation is made. If this act through the space of a molecule, we have $Sv^{2/3}$, the molecular surface tension energy. According to Eötvös this is equal to $3.015 \times 10^{-16}(T_c - T - 6)$, using absolute units and the volume of one molecule, and assuming that the number of molecules in a c.c. of gas under standard conditions is 2.77×10^{19}. This value, $Sv^{2/3}$, must be a function of the difference in molecular cohesive energy in the liquid and vapor, or $M^2K/v - M^2K/V = fSv^{2/3}$. At low temperatures M^2K/V drops out and at absolute zero $M^2K/v_0 = fSv^{2/3} = 3.015 \times 10^{-16}(T_c - 6)f$. To find "$f$" I had recourse to Thomas Young's formula: $S = rK/3 = rM^2K/3v^2$; r being the radius of action and equal to $v^{1/3}$ at absolute zero. Maxwell and Lord Rayleigh have a different coefficient from Young's, *i. e.*, 3/20 instead of 1/3. I could not decide which of these was right, but Maxwell's gives a value for the internal pressure requiring an impossible value for "b," if substituted in Van der Waals's equation, so that Young's seems to be right, unless I have made an error somewhere. We have then $S = M^2K/3v^{5/3}$; and $Sv^{2/3} = M^2K/3v_0$. Therefore $M^2K = 9.045 \times 10^{-16}(T_c - 6)$. If this value for M^2K is substituted in Van der Waals's equation using the critical data for pentane, ether, isopentane and benzene, "b"$_c$ is found to have very nearly the uniform value in all of $V_c/2.07$. Van der Waals found, by computing "a" from the coefficient of compressibility, that b_c was $V_c/2.03$; so the two results agree very well. The value obtained from the surface tension is, therefore, tolerably correct. The value of M^2K has been computed for a large number of substances from the critical temperature, pressure and volume, and from the surface tension; and the results are throughout in close agreement.

Having thus found M^2K, the volume "b" of the molecules in the liquid and vapor of pentane at 180° was computed. In the vapor it was 140.3 c.c., and in the liquid 124.24 c.c. for gram molecular quantities. The volume of the molecules in the vapor is, therefore, certainly larger than in the liquid.

4. *The Nature of Cohesive Mass. Relation between Cohesion and Gravitation and the Number of Valences. A Method of Determining the Valence of Compounds.—The very interesting relationship has been discovered that the value M^2K, the factor proportional to the square of the cohesive mass of a molecule, is equal to the constant* 2.97×10^{-37} *multiplied into the two thirds power of the product of the molecular weight and the number of valences in the molecule.* This relationship holds in such a variety of substances that it seems universally true. It gives a valuable means of computing valences, when the critical data are known. Van der Waals's constant "a" can then be computed very exactly for non-associating substances when the valence is known by the formula: $a = 2.97 \times 10^{-37}(\text{Wt. Val.})^{2/3}N^2$. The value is given in absolute units. N is the number of molecules in the volume taken.

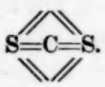
TABLE I

Substance	Mol. Wt.	Valences	M^2K(Wt × Val)$^{2/3}$
Methyl formate ...	60	16	2.94×10^{-37}
Pentane	72	32	3.00
Iso-pentane	72	32	2.92
Ether	74	28	2.92
Benzene	78	30	2.93
Hexamethylene ...	84	36	2.92
Hexane	86	38	3.04
Ethyl acetate	88	28	2.95
Propyl acetate ...	102	34	2.97
Ethyl propionate .	102	34	2.95
Octane	114	50	3.14
Diisobutyl	114	50	2.98
Carbon tetrachloride	153.8	16	3.03
Stannum tetrachlor.	260.8	16	2.89
(Methyl alcohol ..	32	10	4.634)
Helium	4	1	2.90
Hydrogen	2	2	3.07
Oxygen	32	2	2.88
Argon	39.9	1	3.10

The short table illustrates the constancy of c, the quotient, when the factor M^2K, computed in the manner just mentioned from the surface tension, is divided by the two thirds power of the product of the molecular weight and the number of valences per molecule.

It will be seen from this table that the substances of which the valence is not doubtful, and of which the critical data have been so carefully determined by Young, give a constant value of c. Associating substances, like methyl alcohol, give a quotient higher than the average. A higher mean molecular weight and valence number must obviously be taken for these substances. The high figure for argon may indicate that at the temperature at which its density was determined, there was a slight association, a few two-atom molecules being present. If this is the case, 39.9 would be probably a mean molecular weight. If the theoretical value of 2.97 be supposed to be correct instead of 3.10, it would be necessary for the mean valence number to be 1.06; and from this the atomic weight of 37.5 instead of 39.9 would be computed. The critical data of krypton do not fall in line with the formula; and xenon, if the critical data are right, must be taken as bivalent. In all the argon group, the valence must be taken at least as unity. These substances can not be considered as having zero valence, as that would make the value of c infinite, unless the cohesive mass was zero also. But that this is not zero is shown by the fact that the gases can be liquefied. The critical temperature of helium was taken as 7° Abs. instead of 5° as given by Onnes, and 8° as suggested by Dewar. Hydrogen gives a constant close to 2.94, if Sarrau's critical data are taken, but not when those of Olszewski are used. Oxygen is taken with a valence of 2 instead of 4. Even with this assumption it is only by using the recent determinations of density made by Mathias and Onnes that a value near to 2.97 can be obtained. These matters will be discussed in the complete paper. It is possible that the coefficients for the computation of M^2K should be different in these simple gases.

One of the most interesting results is that all organic chlorine compounds, with one or two possible exceptions, have trivalent chlorine. The formulas of such compounds will need revision to take account of this fact. Methyl chloride, if free valences do not exist, would need to be written: $H_2C{=}ClH$, which would show at once why it dissociates so easily into hydrochloric acid and methylene. Fluorine is monovalent in fluorine compounds; the other halogens have not been computed. Sulfur is generally hexavalent, but in sulfur dioxide it is quadrivalent. It is hexavalent in carbon bisulphide. The formula might be:



The fact that chlorine is trivalent in its organic compounds confirms Drude's and Pascal's deductions from a study of the refractivity, normal dispersion, and molecular magnetic susceptibility of these compounds. Pascal found fluorine to be monovalent, chlorine to be polyvalent.

The fact that the cohesion is thus determined in part by the number of the valences, and that a relationship, long ago foretold by Laplace, is thus shown to exist between molecular cohesion and refraction and dispersion of light is of great interest. The formula $M^2K = c(\text{Wt. Val})^{2/3}$ shows, on the electronic theory, that the electrons of the atoms and those of the valences differ, and that they can not be summed. Hence the cohesion is proportional to their product, not to their sum. This conception was the starting point of Drude's reasoning concerning the influence of valence on refraction and dispersion. The general result of the establishment of this relationship between valence and cohesion, between gravitational mass and cohesional mass, between cohesion and light refraction, and between cohesion and diamagnetic properties is, on the whole, to lend support to Sutherland's view that molecular cohesion is of a magnetic nature. The fourth power law may possibly bear this out, as he urged. The relation of intramolecular cohesion, or chemical affinity, and intermolecular cohesion is also seen to be a very close one; and the latter is apparently dependent upon the former.

ALBERT P. MATHEWS
UNIVERSITY OF CHICAGO,
May 18, 1912

SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES
SECTION OF BIOLOGY

AT the regular meeting of the Section of Biology, held at the College of the City of New York, March 11, 1912, Chairman Frederic A. Lucas presiding, the following papers were read:

The Number and Kinds of Bacteria in City Dust: C.-E. A. WINSLOW and I. S. KLIGLER.

The authors presented the results of the examination of about 170 samples of dust from streets, schools, houses and public buildings in New York. The total numbers of bacteria found varied from 150,000 per gram to 145,000,000, averaging from 3,000,000 to 5,000,000 from the indoor dusts and 49,000,000 from the street dust. Spores made up usually less than one tenth of the total. The count obtained at body temperature was about half that at room temperature, averaging from 2,000,000 to 3,000,000 per gram in the indoor dusts and 22,000,000 in the street dusts. *B. coli* was usually present; in the street dust an average of 51,000 per gram was found and in two samples over 100,000, while none showed less than 100. The indoor dust, on the other hand, showed an average of between 1,000 and 2,000. Acid-forming streptococci, such as are characteristic of the mouth, were present to the extent of over 1,000 per gram in three fourths of the street samples and one half of the indoor samples. The average for the street samples was about 40,000 per gram; for the indoor samples about 20,000 per gram. The large proportion of these organisms, particularly in the indoor dusts, appears to be significant of buccal pollution.

The Aerial Transmission of Disease: C. V. CHAPIN.

The diffusion of contagion through the room or out of doors only was considered, not droplet infection, which does not take place beyond a meter. Bacteriological evidence was not discussed, though the quantititative work of Winslow on sewer air and spray infection was referred to, a work which he is now extending to dust. Epidemiological study and experiment have been rapidly narrowing the list of alleged air-borne diseases. We now

know that yellow fever and malaria are never air-borne. Experiments have shown that bubonic plague and Mediterranean fever are not. There is no evidence that cholera and typhoid fever are ever air-borne and much that they are not. The spread of influenza out-of-doors does not take place and perhaps not in-doors. The alleged evidence that smallpox virus is air-borne around hospitals is very weak. Careful observation in hospitals has shown that typhus fever, cerebro-spinal meningitis and poliomyelitis do not pass from patient to patient in the same ward. The same is true for uncomplicated scarlet fever and for diphtheria except by contact or close droplet infection. Probably measles and whooping cough, rubella, mumps, chickenpox and smallpox are not air-borne, even in the same room, but further observation may show that such infection may rarely take place.

At the regular monthly meeting of the section held at the American Museum of Natural History, April 8, 1912, the following papers were read:

Sex-linked Inheritance in Poultry: T. H. Morgan.

A summary of experiments carried out with the collaboration of H. D. Goodale: relating especially to the inheritance of the factor for barring in Plymouth Rocks and Dominiques crossed to Langshans. The paper is being published in the *Annals*.

The Spawning Habits of the Sea Lamprey, Petromyzon marinus: L. Hussakof.

An abstract of this communication was published in Science, March 22, 1912, pp. 460–461. The speaker exhibited a small model of the lamprey group now under construction in the American Museum.

Notes on Cuban Marine Fishes: John T. Nichols.

The speaker dealt with the results of a brief collecting trip to Cuba and exhibited various specimens. He passed in review some of the Scombriform fishes. The king fish, *Scomberomorus cavalla*, is highly esteemed, but another species, *S. regalis*, is said to be occasionally poisonous. *S. maculatus*, the Spanish mackerel, was not seen. While *regalis* and *maculatus* occupy more or less distinct areas, *cavalla* is abundant both in Florida, with *maculatus*, and in Cuba, with *regalis;* in the speaker's opinion these two last named species, which are still closely related, have recently become separated through the competition of *cavalla*. Two very widely separated forms, *Arbaciosa rupestris* and *Gobius soporator*, were found inhabiting adjacent rock pools; both were concealingly colored and could have been confused until their distinctive color patterns were noticed.

At the regular monthly meeting of the section held at the American Museum of Natural History, May 13, 1912, the following papers were read:

Note on the Habits of the Climbing Cat-fish (Arges marmoratus) from the United States of Colombia: R. D. O. Johnson.

Although living in streams of high grade and torrential force these fish were enabled not only to hold their place against the current, but even to advance up-stream and to climb out of a steep-walled, deep pot-hole. They did this by means of curious sucker-like adaptations of the mouth and ventral fins. The paper will appear in the *Annals*.

On the Changes in Behavior of the Eel (Conger malabaricus?) during its Transformation: Bashford Dean.

When at Misaki, Japan, the speaker had made observations upon the structure and behavior of a living leptocephalus larva which was kept alive in an aquarium for over three weeks, during this time undergoing its metamorphosis. Especially interesting is the rapidity with which the behavior of the young eel changes from day to day in its methods of swimming and resting, response to stimuli, etc. The speaker suggested that these marked differences in behavior in successive stages were correlated with kaleidoscopic changes in elements of the central nervous system; that when more fully known this would probably afford a suggestive case of parallelism between psychic reactions and neurological conditions. The paper will appear in the *Annals*.

Notes on Certain Principles of Quadrupedal Locomotion and on the Mechanism of the Limbs of Hoofed Animals: William K. Gregory.

The speaker gave a brief résumé of a paper that is being published in the *Annals*.

On the Dictyonema Fauna of Navy Island, New Brunswick: F. F. Hahn.

Read by title. To be published in the *Annals*.

The secretary gave an abstract of a communication from Dr. P. Bachmetjew, of Sofia, relating to the physiology of *Vesperugo pipistrellus* and *Miniopterus schreibersii*. In some cases these bats had been thawed out and the heart action had resumed even after the body had been cooled to — 7° Cent. below the body temperature.

The section adjourned until October 14, 1912.

William K. Gregory,
Secretary